

BLACK-HEADED BUDWORM JOINT SPRAY PROJECT  
Queen Charlotte Islands, British Columbia, 1960

By

Hector A. Richmond

Consulting Forest Entomologist

BRITISH COLUMBIA LOGGERS' ASSOCIATION

*550 Burrard Street  
Vancouver 1, B.C.*

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## INTRODUCTION

Control was prompted as a result of an intensive egg survey undertaken in October 1959, results of which indicated a general increase in population in 1960. The most critical areas were considered to be between Skidegate and Cumshewa Inlets where egg counts were high and 1959 defoliation moderate to heavy. In places there still persisted injury that resulted from the previous budworm outbreak.

In the vicinity of Alliford Bay, egg counts showed a large increase and defoliation averaged over 50% of current foliage and 25% of total foliage. The upper crown of many trees was denuded for 2 to 4 feet.

In the South Bay area eggs were considered "heavy" with as many as 77 per ten inch branch sample. The upper third of most trees was very severely defoliated and defoliation averaged 65% of total foliage in many cases.

At Copper River current defoliation, plus the accumulated damage of previous years, placed the area in the "hazard" class. A similar situation prevailed in the Moresby area.

It was considered advisable, therefore, to proceed with control operations over these designated areas in 1961.

## AGENCIES INVOLVED

The project was promoted by the B.C. Loggers' Association in association with the Forest Biology Division of the Federal Department of Agriculture. The following companies were involved;

Crown Zellerbach Canada Limited, MacMillan, Bloedel & Powell River Limited, Rayonier Canada Limited and the Provincial Government. The contracting company for application of spray was Skyway Air Services Ltd., Langley, B.C. Biological work and assessment of insect development and spray results were conducted by the Forest Biology Division, Victoria; J.M. Kinghorn in charge of field crew. Fishery research was done by the Federal Department of Fisheries, Vancouver; Ian Todd, Research Officer in charge. Administration and supervision of the bacterial spray tests was handled by three specialists, Dr. T. Angus and Dr. A. Heimple, Federal Biological Control



Institute, Sault Ste. Marie, Ontario; and Dr. R. Fisher, Vice-President Bioferm Corporation. Field work was carried out by Mr. J. M. Kinghorn and his field crew.

Accommodation for personnel was arranged in the unused Air Force Hospital building at Alliford Bay, and meals were procured at the cookhouse of the Alliford Bay Camp.

Aircraft and the mixing station was established on the Sandspit air strip.

#### SPRAY MATERIALS AND AIRCRAFT DETAIL

Because of the restricted nature of the programme only one TBM Grumman Avenger aircraft was used. The machine was calibrated to release 131 gallons per minute over a 440 foot swath at a flying speed of 150 m.p.h.

The principal spray used was DDT formulated by Skyway at Langley and shipped as an oil concentrate to Sandspit where it was diluted to the required formulation. This concentrate was made to contain 2 pounds technical grade DDT per U.S. gallon in W.T. base oil. This was later diluted at Sandspit with diesel oil to give  $\frac{1}{4}$  pound DDT per U.S. Gallon or a final product of 3 1/8% DDT. It was applied at a rate of one U.S. gallon per acre.

The bacterial insecticide *Bacillus thuringiensis* was applied as an oil emulsion and was composed as follows:

- 1.8 gallons Span 80 and Tween 80
- 29 gallons furnace oil
- 14 lbs. microcel A
- 60 lbs. Thuricide 60B
- 3.2 lbs. Sodium nitrate
- 3.4 gallons water

Three plots were sprayed in the *Bacillus* tests as follows:

- Plot 1 - 11 gallons spray concentrate plus 29 gallons oil sprayed with two passes of aircraft.
- Plot 2 - 14 gallons spray concentrate, 41 gallons oil, three passes of aircraft.
- Plot 3 - 55 gallons furnace oil.

Detail of this test is shown in Appendix No. 4.

PROJECT ORGANIZATION

(a) Areas Sprayed

Based on an autumn egg survey, areas of high hazard were defined as shown on the map. Acreages involved were calculated as follows:

South Bay - Alliford Bay	19,890 acres
Copper River Area	6,100 "
Moresby Camp	4,860 "
<hr/>	
	30,850 acres
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As a result of recent cut-over areas and some modification of boundaries made in the field, company ownerships were:

Powell River Company	7,290 acres
Crown Zellerbach Canada Limited	14,774 "
Provincial	4,374 "
Rayonier Canada Limited	4,722 "
<hr/>	
	31,160 acres
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(b) Spray Blocks

The spray area of some 32,000 acres was broken into eight blocks, each defined by some prominent land mark or topographical feature. Preliminary flights were made in company with the spray pilot to familiarize him with the area.

The approximate acreage of sprayable timber of each block was as follows:

Block 1A & 1B	2 & 3	4	5	6	7	8
3990	4000	4532	3166	2492	5586	2698

(c) Radio Control

Portable radios were procured from the B.C.Forest

Service with the idea of establishing direct contact between field parties, the field base at Alliford Bay, the air strip and the plane. This proved useless to the operation and a general nuisance to the Forest Service radio net work. Through the cooperation of the B.C. Airlines, messages were transmitted between Moresby, Alliford Bay, Sandspit and the aircraft, which proved very helpful at times although decidedly inconvenient.

(d) Dates and Progress of Operation

Although the spraying was expected to occur between June 15th-25th, the operation was postponed to the period July 17th-25th, due to the very backward weather encountered.

Installation of the storage tanks, pumps, etc., commenced June 13th, and the aircraft and crew arrived June 16th. A check on the spray pattern and calibration of equipment was done June 22nd. The aircraft was recalled by Skyway June 24th, subject to return on demand when conditions for spraying became more favourable. The plane returned July 5th, and was again recalled by Skyway and substituted by another TBM and pilot July 10th. This necessitated a second familiarization flight with the new spray pilot and calibration of the new plane, which was completed July 17th.

Spraying commenced July 17th and continued to July 19th, when mechanical troubles grounded the plane. Two engineers from Bristol Aero-Industries Ltd., Vancouver, were flown in to correct the trouble which work was completed by 2:00 a.m., July 20th. Spraying resumed at 4:00 a.m., July 20th. The spraying was completed July 23rd.

Bacillus spray (on experimental plots), was applied July 24th.



(e) Record of Spray Application

Date	Gallorage (Imperial)	Block No.	
June 22	31.1		Pattern check
23	35.1		" "
23	122.2		Sachs Creek Fish
July 17	722.4	7	Test
	500	7	
	500	7	
	500	2-3	
	500	2-3	
	500	2-3	
	500	2-3	
	500	2-7	
	500	2-3	
	500	2-3	
18	500	3	
	500	3	
	500	4	
	500	4	
	500	4	
	500	4	
	500	4	
	500	6	
	500	5	
	500	5	
20	500	5	
	500	5	
	666	5	
	666	5-6	
	666	5-6	
	666	5-6	
	666	1 B	
	666	1 A	
	666	1 A	
	666	1 A	
	666	1 A	
21	666	1A-1B	
	666	8 A	
	666	7	
	666	4	
	666	7	
	666	7	
22	666	7	
	666	4	
	666	8	
	666	8	
23	700	8 B	
	700	3-4	
	700	7	

Total gallorage sprayed 26664.8 Imperial gallons = 31997.76 U.S. gallons.

SAFEGUARDS FOR FISH

After much preliminary planning with the Department of Fisheries in Vancouver, and a special meeting with their field men from the Queen Charlotte Islands, it was decided to

- (a) hold a special meeting with the Fisherman's Union at Queen Charlotte City when the entire plan and safeguards would be explained to them and,
- (b) to arrange a pre-control test spray over Sachs Creek, using the  $\frac{1}{4}$  pound dosage of DDT to observe its effect on fish. It was felt that such a plan would demonstrate to the fishermen our good faith in working toward a safer and more acceptable spray formulation.

Accordingly, Mr. J.M. Kinghorn, Federal Forest Biology Division, and Mr. Ken Jackson, Department of Fisheries, proceeded to the Queen Charlotte Islands well ahead of the operation, and in a special meeting with the Fisherman's Union outlined our intent and concern over the fish problem. This preliminary meeting contributed to a very large extent in the avoidance of any opposition to the control programme although, naturally enough, there was considerable concern among the fishermen over the success of the venture.

Many other precautions were included in the plans toward the safety of the fish. Waterways were not used as dividing lines between spray blocks and each waterway was studied according to its specific peculiarities as indicated in the following:

(a) Smoke Bombs

In each case smoke bombs were used to indicate to the aircraft the direction of drift and if an unfavourable air movement was observed spray would not be released on that side of the river that would permit spray drift on to the water. This was a very workable arrangement and the smoke bomb gave a sufficient cloud of smoke to be observed from a long distance by the plane.

(b) Copper River

In addition, a special plan was developed for the Copper River by the writer in conjunction with Mr. J.M. Kinghorn, Forest Biology Division. Terms of this proposal were presented in a memo to the Department of Fisheries, Vancouver, which follows:

"After a careful review of the Copper River with respect to budworm spraying, in company with Mr. James Kinghorn, Forest Biology Division, the following proposals are made:



1. All logged-over land will be eliminated from the spray area. This will eliminate entirely the lower portion of the river from the mouth to the southern boundary of Lots 877 and 876 as shown on the accompanying map and as well, much of the land adjacent to the river within the proposed spray area.

2. On Lot 879 spraying will terminate at the ridge of land sloping to the west bank of the river. This unsprayed area will join with the slash as shown on the map.

3. The small area of timber at the northeast corner of Lot 878 which extends to the river bank on the east side will not be sprayed, except for a portion that occurs on the eastern slope where spray could not reach the river.

4. A small area at the southwest corner of Lot 878 will be omitted where logging is now in progress.

5. On Lots 883 and 882 all timber adjacent to the river bank will be withdrawn from the spray zone. On the west side the spray boundary will be moved eastward to the ridge of high land that constitutes the west side of the river basin. On the east side the spray zone will be moved eastward away from the river to a line that corresponds to the extremity of the slash area.

6. The complete elimination of the area of timber along the northern part of Lot 881 which fringes the southern bank of the river.

The above proposals will eliminate entirely the Copper River from the spray zone, and since ridges of land are used to mark the extremity of spray, there should be small likelihood of any degree of spray drift reaching the water."

H.A.Richmond

June 9, 1960.

(c) Pre Control Assessment - Sachs Creek

An attempt was made to determine the potential hazard of the quarter pound dosage DDT to cohoefry by application of two swaths of the formulation over the course of Sachs Creek. Four live box stations were established, each station consisting of one covered live box containing 110 cohoefry; one open box containing 110 fry; a vertical series of live boxes reaching to a depth of  $2\frac{1}{2}$  feet with fry confined as follows; Top 6 inches 25 fry; 6 to 12 inches 25 fry; 12 to 30 inches 50 fry. Spray assessment cards showed spray deposits. Bottom sampling for aquatic food was undertaken periodically.

Results of two passes over this stream gave a very light kill in the upper 6 inch level but non deeper. No aquatic insect life was affected.

Further tests conducted over the control area by the Department of Fisheries using live boxes similar to those in Sachs Creek showed no mortality to either caged or free fish nor aquatic insects, in the course of the normal spray operation.

### RESULTS

Results of the project as determined through the assessment work conducted by the Forest Biology Division, Federal Department of Agriculture, are given in greater detail in the appendix pages.

In summary, however, control uncorrected by natural mortality, averaged from 70 to 100 percent. Since a natural decline of budworm progressed through the summer, due probably to the very cold summer, not all of this mortality can be attributed to the spray. Evidence of the effectiveness of the quarter pound DDT treatment was found in the sampling of populations on sprayed plots where mortality following spraying was much greater than in unsprayed plots.

Results of the bacterial spray (*Bacillus thuringiensis*) was applied under unfavourable conditions but none the less, results were very encouraging. Field sampling two days after spray application showed a mortality from bacterial infection in excess of 60%. Furthermore, larvae collected from an unsprayed area and fed on foliage taken from the sprayed plots, showed a mortality of 80% to 90% depending on dosage.

During both operations studies were conducted by the Federal Department of Fisheries. Results of the DDT tests showed a slight effect on caged fish in Sachs Creek, but practically no effect on fish caged in streams within the general area of the spray operation. There was no effect on the aquatic insect life. In the case of the bacterial spray there was no effect on either the fish nor their aquatic insect food.

QUEEN CHARLOTTES 1960 SPRAY PROJECT

Statement of Expenditures

Aircraft Spraying-Skyways Air Services Ltd.	
31,729.8 gallons @ 1.79 per gal.	56,796.34
Board and Room-Skyways Crew	731.79
Taxi Service	593.95
H.A.Richmond fees -	2,185.00
" expenses including air travel and meals	697.91
	<u>\$61,004.99</u>

Division of Costs

On basis of 31,160 acres sprayed, the cost per acre was 1.957798 per acre.

Shares as per agreements executed -

Rayonier	4,722 acres @ 1.957798		9,244.73
Others	26,438 " "	<u>51,760.26</u>	
of which:			
1/3 is for account of Province			17,253.42
66.96% of 2/3 - Crown Zellerbach		23,105.78	
33.04% " - M.B. & P.R.		<u>11,401.06</u>	<u>34,506.84</u>
			<u>\$61,004.99</u>

Position of Contributing Bodies

	Share 1960 Costs to date	Credit Balance from 1959	Paid in 1960	Balance	
				Dr.	Cr.
Prov. of B.C.	17,253.42	137.90		17,115.52	
Rayonier	9,244.73	111.89	10,000.00		867.16
Crown Z.	23,105.78	137.90	15,000.00	7,967.88	
M.B. & P.R.	11,401.06	137.89	8,000.00	3,263.17	
	<u>61,004.99</u>	<u>525.58</u>	<u>33,000.00</u>	<u>28,346.57</u>	<u>867.16</u>



Balance Sheet as at August 29th, 1960:

Cash in Bank 1,040.96

Due from participants:

Province of B.C.	17,115.52
Crown Zellerbach	7,967.88
M.B. & P.R.	3,263.17
	<u>28,346.57</u>

Less:

overpayment advanced by Rayonier Ltd.	<u>867.16</u>	27,479.41
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Other Receivables -

Fed. Dept. of Fisheries	425.00
Fed. Dept. of Forest Biology	3,620.00
Prov. Game Dept.	<u>30.00</u>
	4,075.00

Accounts Payable:

Skyway Air Services	28,796.34
B.C. Loggers' Association	864.03
M.B. & P.R. - Alliford Bay Division	2,935.00

32,595.37

32,595.37

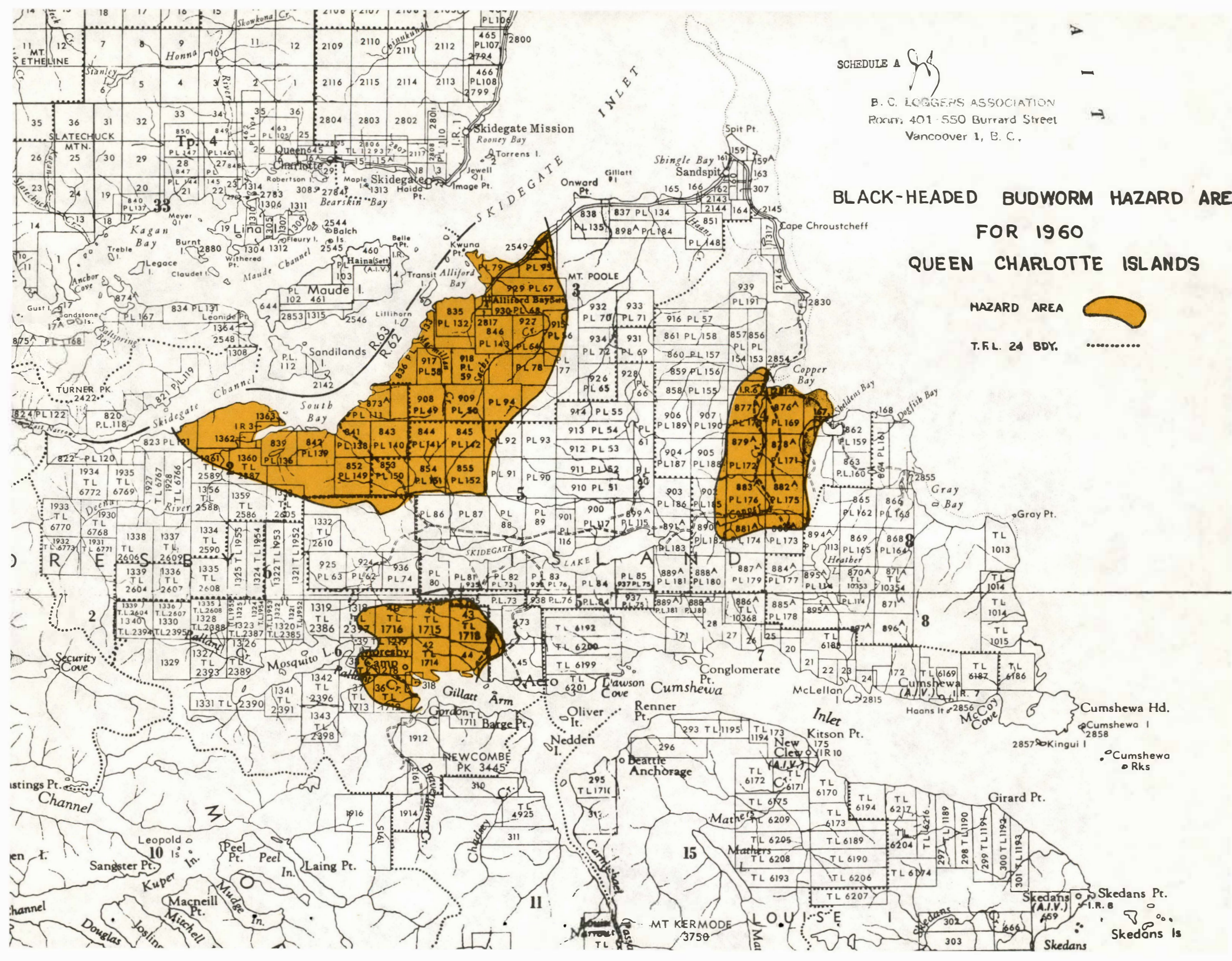


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APPENDIX

In this section are included miscellaneous reports, etc., relating to this project. Because of the length of some, the contents are only summarized here. Original reports are available if requested.

Appendix No. 1

SUMMARY OF BLACK-HEADED BUDWORM INFESTATION  
Queen Charlotte Islands - October 1959.

by  
Dr.G.T.Silver

A budworm egg survey was undertaken in October 1959, by the Federal Forest Biology Division, the objectives being:

- (1) To assess the amount of defoliation and damage to date,
- (2) To obtain egg counts which would enable the expected defoliation in 1960 to be predicted, and,
- (3) To obtain a satisfactory basis for calculating the population trend and predicting probable future damage in 1960.

Details and methods are set forth in their special eleven page report, but their conclusions are extracted below:

"Hazard Rating for 1960

Hazard ratings were worked out for each of the 82 points sampled (Map 3).

Defoliation on Graham Island is generally expected to be light. The only high hazard area is at Towhill. Defoliation of medium intensity can be expected at Awun Lake and along Skidegate Channel and Maude Island.

Damage to some stands on Moresby Island is expected to be heavy. Heavy defoliation should occur at Jedway and at Takelley Cove on Lyell Island. The medium damage forecast for Tasu Sound and from Crescent Point to Lagoon Inlet is based more on damage to date than expected defoliation in 1960, as egg counts were generally light or very light.

The critical area which should be examined very carefully is between Skidegate Inlet and Cumshewa Inlet where the egg counts were high, defoliation in 1959 medium to heavy, and the stands have not completely recovered from the old outbreak.

In the vicinity of Alliford Bay egg counts ranged from



light to heavy. Defoliation in 1959 was medium with up to 50 per cent of the current year's foliage lost and total defoliation of up to 25 per cent. The upper crown levels were heavily defoliated with the top two to four feet on some trees completely stripped. Logging is in progress in this area at the present time. The South Bay area (P.L. 140, Deena River, and South Bay) has the highest hazard of any locality. Egg counts here were all heavy with the largest count, 76.7 eggs per 10 inch tip, occurring on P.L. 140. Defoliation in 1959 was heavy with up to 65 per cent of the current foliage lost, many tips completely stripped, and total defoliation to some trees as high as 50 per cent. Some of this total defoliation was the result of the previous outbreak which still shows in the form of dead branch tips and dead tops. The tips of about 1/3 of the trees examined were stripped. Approximately 20,000 acres of mature timber is included in this high hazard area.

At Copper River (P.L. 170) a medium egg count combined with heavy old damage places this area in a high hazard category. Many trees here produced no new foliage in 1959. The approximate area involved is about 4,000 acres.

A very heavy egg count at T.L. 1218 on the Aero-Moresby Road combined with medium to heavy defoliation in 1959 can be expected to result in heavy damage in 1960. The approximate area involved is 5,000 acres.

It is almost impossible to predict the intensity of damage anticipated for the high hazard areas. Based on past experience it is reasonably safe to predict that stands containing a high egg count will probably lose all the 1960 growth, which will bring total defoliation close to the critical point of 60-70%. Heavy top defoliation and possibly top-kill is imminent and some tree mortality could result.

### Discussion

The black-headed budworm reached a very high population level in 1959. The number of larvae obtained per 3-tree beating sample was exceedingly high in some areas, particularly when 200 larvae per sample has been considered as a heavy population.

Based on the small number of egg samples collected in 1958, the increase in the number of eggs is very significant. Barring any unforeseen mortality, the larval population and associated defoliation in some areas can be expected to exceed the 1959 defoliation, particularly in the mature stands along the south shore of Skidegate Inlet.

As pointed out before, the amount of defoliation is not always in proportion to the number of larvae. In some cases 100 larvae per sample caused more defoliation than resulted in

other areas where 600 larvae per sample were collected. The time at which larval collections are made could be an important factor. It might be possible to collect 1,500 larvae in an area when the larvae are very young, but later collections might be less than this number. A safe assumption would be to expect heavy defoliation in areas where collections in mid-July range from 150 to 400 larvae.

There is no indication that parasites are numerous enough to give any degree of control in 1960. There is also no indication of disease developing in the field populations.

Predicting anticipated damage in a black-headed budworm infestation is always a difficult procedure. In the first place we are dealing with a biological problem, and past experience has proved that insect populations behave unpredictably. Weather conditions, which can result in a sudden collapse of an outbreak, cannot be forecast with enough certainty to be of any value.

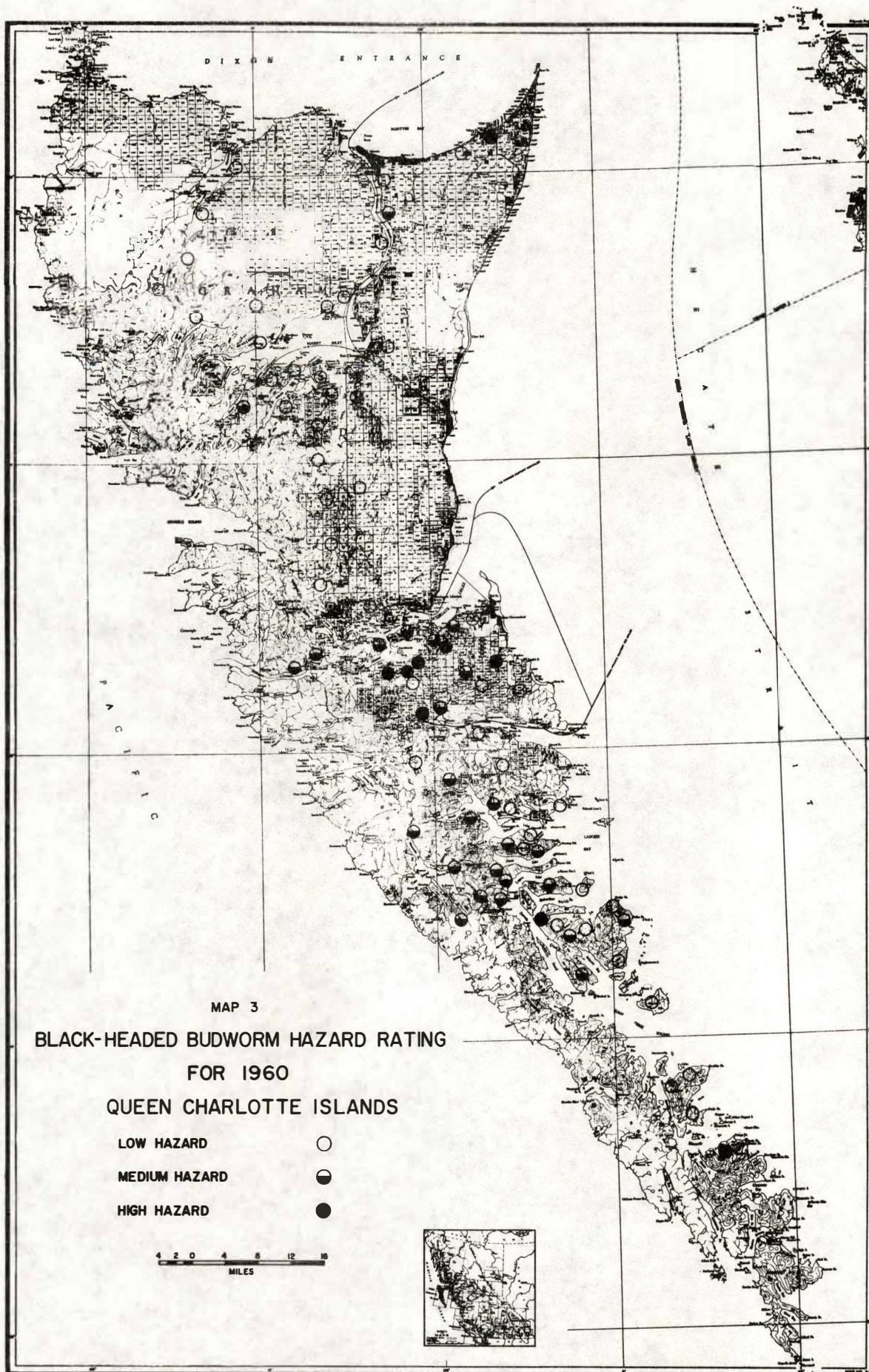
Another consideration is the defoliation in 1959 as related to the 1958 egg counts. Based on the present classification system the one heavy egg count in 1958 resulted in heavy defoliation, the medium egg counts also resulted in heavy defoliation, and of the five light counts defoliation was light in two and of medium intensity in three areas. If these examples are indicative of black-headed budworm in the Queen Charlotte Islands, the hazard ratings as presented in this report are probably on the conservative side.

### Conclusions

Based on available information the black-headed budworm infestation on the Queen Charlotte Islands is increasing in intensity. Defoliation in 1960 can be expected to be heavier than in 1959 throughout most of the infested area.

Stands which should be considered in immediate danger of heavy defoliation, top-kill, and possibly some tree mortality total about 30,000 acres in extent. These stands are in three locations: South Bay to Alliford Bay (20,000 acres), Copper River (4,000 acres), and at the head of Gillatt Arm on the Aero-Moresby Road (5,000 acres). The situation in these areas is further aggravated by the damage still evident from the previous outbreak. It would be advisable to consider treatment of the above areas if the timber is involved in long range management plans. A chance could be taken in areas where logging operations are in progress which could handle salvage cutting if necessary."







Appendix No. 2

Comparison of Egg Population  
1959 & 1960 - October, 1960

An egg survey was undertaken in October 1960, to check on the probable course of the infestation in 1961. Due to the obvious reduction in population, this survey was restricted over the 1959 survey as indicated on the accompanying map. A comparison of eggs per 10 inch branch sample is shown below:

Black-Headed Budworm, *Acleris variana* (Fern.), Egg Samples  
1959 and 1960

<u>Location</u>	<u>Number of eggs in sample-1960</u>	<u>Ave.No.per 10" Tip 1959</u>	<u>1960</u>
Powvrice Bay, Lyell Island	2/15	0.33	0.13
Beresford Inlet	1/15	7.73	0.06
Rockfish Harbour, Louise Island	0/15	2.00	0.00
Lagoon Point, Moresby Island	1/15	3.40	0.06
Thurston Harbour, Talunkwan Island	0/15	1.27	0.00
Tanu Island	1/15	5.53	0.06
Dana Inlet, T.L. 1209	0/15	----	0.00
Dana Inlet, Moresby Island	5/15	2.80	0.33
Ramsay Island	2/15	6.00	0.13
Maude Island	3/15	8.07	0.20
Alliford Bay, Moresby Island	0/15	17.83	0.00
Copper River	4/15	8.93	0.26
Heather Lake, Moresby Island	0/15	4.53	0.00
South Bay, Moresby Island, P.L. 140	1/15	76.67	0.06
Mosquito Lake, Blk. 1323	63/15	5.27	4.20
Near Moresby Camp, T.L. 1716	4/15	31.67	0.26
South Bay-Skidegate mainline	2/15	2.40	0.13
Peel Inlet	1/15	0.60	0.06
Renner Point, Louise Island	4/15	3.53	0.26
Traynor Creek, Louise Island	0/15	13.07	0.00
Beljay Bay, Lyell Island	5/15	7.60	0.33
Takelly Cove, Lyell Island	0/15	1.20	0.00

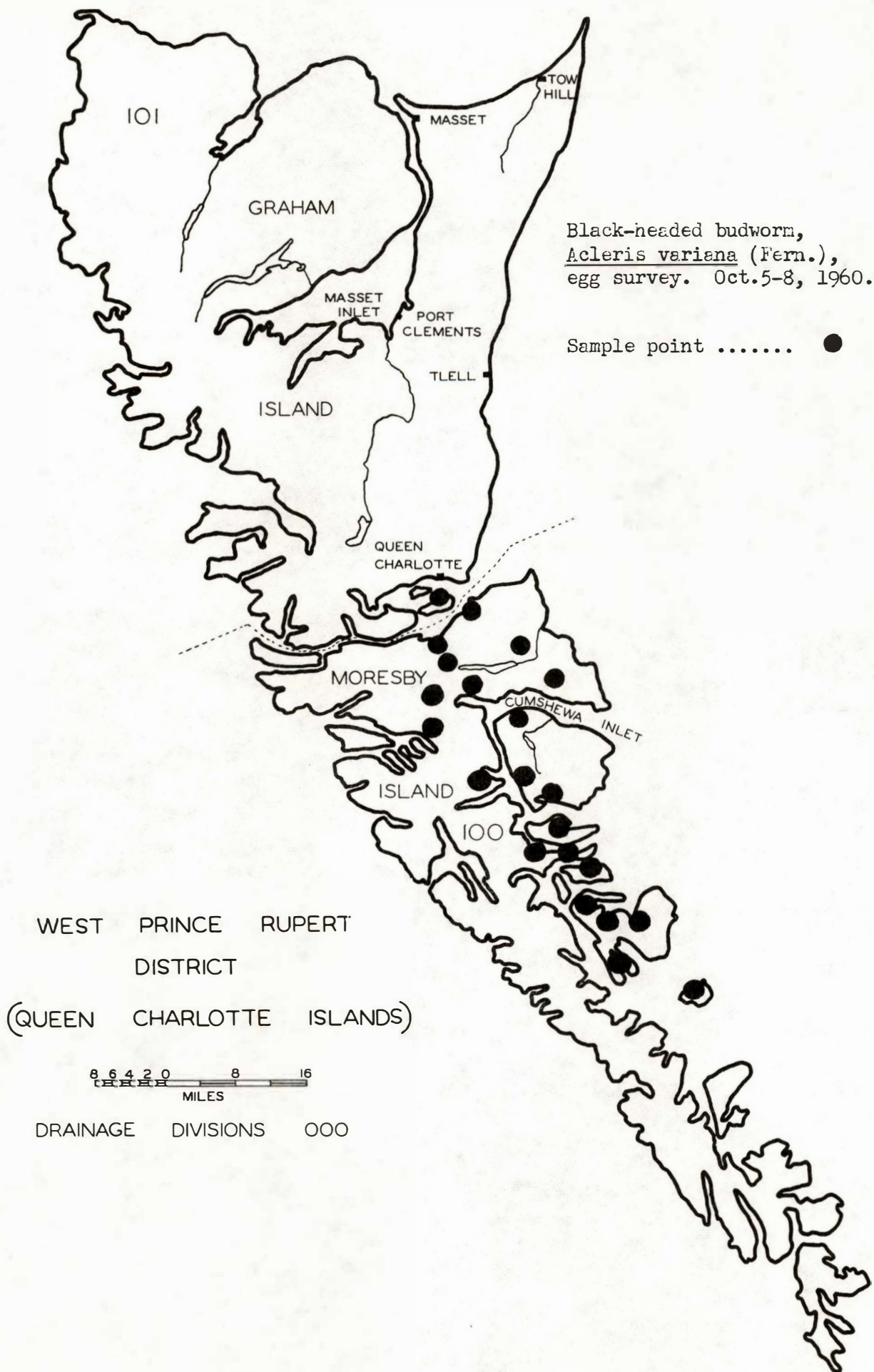
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1959 and 1960

<u>Location</u>	<u>Number of eggs</u> <u>in sample-1960</u>	<u>Ave.No.per 10" Tip</u> <u>1959</u>	<u>1960</u>
Powvrico Bay, Lyell Island	2/15	0.33	0.13
Beresford Inlet	1/15	7.73	0.06
Rockfish Harbour, Louise Island	0/15	2.00	0.00
Lagoon Point, Moresby Island	1/15	3.40	0.06
Thurston Harbour, Talunkwan Island	0/15	1.27	0.00
Tanu Island	1/15	5.53	0.06
Dana Inlet, T.L. 1209	0/15	----	0.00
Dana Inlet, Moresby Island	5/15	2.80	0.33
Ramsay Island	2/15	6.00	0.13
Maude Island	3/15	8.07	0.20
Alliford Bay, Moresby Island	0/15	17.83	0.00
Copper River	4/15	8.93	0.26
Heather Lake, Moresby Island	0/15	4.53	0.00
South Bay, Moresby Island, P.L. 140	1/15	76.67	0.06
Mosquito Lake, Blk. 1323	63/15	5.27	4.20
Near Moresby Camp, T.L. 1716	4/15	31.67	0.26
South Bay-Skidegate mainline	2/15	2.40	0.13
Peel Inlet	1/15	0.60	0.06
Renner Point, Louise Island	4/15	3.53	0.26
Traynor Creek, Louise Island	0/15	13.07	0.00
Beljay Bay, Lyell Island	5/15	7.60	0.33
Takelly Cove, Lyell Island	0/15	1.20	0.00





Appendix No.3

Preliminary Report on  
BLACK-HEADED BUDWORM CONTROL PROJECT  
Queen Charlotte Islands - 1960

by

Mr. James Kinghorn, Forest Biology Laboratory, September 29th, 1960

1. DDT Operational Spray ( Forest Biology Laboratory, Victoria)

The egg survey conducted during the autumn of 1959 showed that a potentially dangerous budworm population was present on parts of Moresby Island. In view of the poor condition of some trees, control was undertaken on 31,500 acres in the vicinity of Moresby and Skidegate Inlets and Copper River.

A dosage of  $\frac{1}{4}$  lb. DDT per U.S. gallon per acre was used in order to lessen the hazard to fish. Fish damage was also avoided by not spraying directly over the Copper, Pallant, and Deena Rivers.

Egg samples taken in April, 1960, indicated that some winter loss had occurred, but that high numbers of insects were still present.

When branch sampling was begun on June 1st, most eggs had not hatched. Earlier control studies have shown that DDT aerial spraying is not effective against this insect until at least 50 per cent of the larvae are in the second instar. On the basis of samples taken from regeneration hemlock, it was forecast that this point would be reached by the last week of June. Subsequent sampling of under and overstory hemlock in mature stands soon showed that development was not as far advanced as in young stands. Furthermore, the weather remained cool and wet throughout June and most of July, so that it was not until July 10th, that budworm on understory hemlock reached the stage for effective spraying.

Bud burst on overstory hemlock did not occur until early July. At the time when large numbers of eggs were hatching on the overstory, the buds had not begun to burst. Samples taken during this period, and subsequent lack of serious defoliation to the overstory indicated that many newly hatched larvae never survived because of the lack of opened buds.

On June 23rd, two DDT swaths were sprayed over Sachs creek to determine the potential hazard of the  $\frac{1}{4}$  lb. dosage to Cohoefry. Although it was anticipated that the spray would not

effect control of the budworm at this early date, an attempt was made to ascertain the result. As forecast, control at this early stage was not effective. A few of the larger larvae were killed, but most insects were either in the egg stage or survived because they were protected by the buds that were only just starting to open.

Operational DDT spraying was scheduled to commence on July 11th, but heavy rainfall delayed the start until July 17th. By July 23rd, the operation was finished. Mechanical difficulties with the aircraft, and unsettled weather during the period slowed operations, and in some areas insecticide was applied in marginal spraying weather.

Spray coverage appeared to be adequate. Of 21 assessment plots, all but one received some deposit. Most check plots were far enough away from the spray block to avoid contamination. One check plot was fully sprayed and a minute deposit was detected on another two.

From hatching to pupation a defoliator population normally diminishes through parasitism and other natural controls. Cool wet weather accelerated the decline of the budworm population in this situation. In retrospect it can be seen that unfavourable weather for budworm persisted long enough to result in an over-all net decrease in population for the season in both sprayed and unsprayed areas. However, at no time during the operation was it possible to predict with certainty that poor weather would continue. By the end of July, populations in unsprayed stands were very low. Hence it is difficult to determine the actual amount of mortality that was attributable to the spray.

Control, uncorrected for natural mortality, ranged from 70 to 100 per cent. Obviously where untreated populations were undergoing catastrophic natural decline, the theoretical percentage control attributable to the spray was much less than indicated by the foregoing. Evidence that the  $\frac{1}{4}$  lb. treatment was effective can be drawn from several plots sampled three to five days after spraying where population decline was much greater than would be anticipated had the trees been left untreated.

From the meagre evidence that could be salvaged from this collapsing population, it can be stated that there is good probability that  $\frac{1}{4}$  lb. DDT per acre will control the black-headed budworm. An effort should be made to check this finding at an early date, but it is urged that the work be done on an experimental, rather than an operational basis. Experience has demonstrated that when experimental and operational spray programmes are combined, the urgencies associated with the latter invariably work to the detriment of the former.



II BACTERIAL INSECTICIDE EXPERIMENTS (Insect Pathology Research  
Institute, Sault Ste. Marie,  
and Forest Biology Laboratory  
Victoria.)

Before this season it was not certain that *Bacillus thuringiensis* would kill the black-headed budworm. During July, water and oil suspensions of the bacterium were hand-sprayed on potted hemlock seedlings infested with budworms. After one week, 98 per cent of the 125 larvae had died, and diagnosis positively established that 58 per cent of these were infected with B.t. The oil treatment gave somewhat better results than the water suspension. Although the spray dosages were high, the test was sufficient to show that this budworm can be killed by the bacterium.

On July 24th, immediately after the DDT operational spraying was complete, two plots in regeneration hemlock stands were sprayed with B.t. suspended in oil. A third plot was sprayed with oil alone as a check. One B.t. plot was sprayed at the nominal rate of 1.3 lb. of Thuricide concentrate (containing 60 billion viable spores per gram) per acre; the other was applied at the rate of 2.8 lb. per acre. Spray was applied with a Grumman Avenger aircraft equipped to deliver 112 gallons per minute. To achieve the light and heavy dosages, two and three passes, respectively were required over the center lines of the plots. Deposits of the bacterium on both plots were heavy, although the spores tended to clump into aggregates readily visible to the naked eye.

Budworm populations in the plots, similar to the general trend in the locality, were low and declining sharply at the time of treatment. A population reduction evaluation of the treatments was thus not possible. However, about 80 per cent of the dead larvae collected from the plots were infected with B.t. Healthy larvae collected from an unsprayed area were placed on sprayed foliage collected from the plots. Larvae on foliage from the light dosage plot suffered 80 per cent mortality while 90 per cent confined on the foliage from the heavy dosage plot succumbed. Diagnosis showed that all of these larvae were infected with B.t. None of the dead larvae collected from the oil treated check plot contained the bacterium.

Although the lack of large numbers of insects on the plots makes it impossible to compare the efficiency of B.t. with DDT spraying, the experiment has established that black-headed budworm can be killed with B.t. dosages that are within the range of practicability for aerial spraying. On the basis of this initial work, further experimentation can be justified. It is anticipated that the usefulness of the material can be improved with better formulation and application techniques.



Appendix No. 4

NOTES ON A THURICIDE TEST AGAINST THE BLACK-HEADED BUDWORM

QUEEN CHARLOTTE ISLANDS, 1960

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Field experiments designed to test the effect of *Bacillus thuringiensis* on the black-headed budworm in British Columbia and the spruce budworm in New Brunswick, were planned in the spring of 1960. Both experiments were planned so that the spray would be applied when the insects reached their fourth instar. The New Brunswick experiment was carried out at the end of May and during June. It was anticipated that black-headed budworm would reach the fourth instar by the first week of July on the Queen Charlotte Islands. Cool weather and a DDT operational spray programme delayed the B.C. experiment until July 24th. The following is a detailed account of the test;

Three experimental plots were established during June. Selecting the plots was difficult because it was necessary that they be located in infested regeneration hemlock stands not more than 40 feet high (in order to use the branch sampling technique), that they be accessible by road, and that they be situated far enough from DDT areas to avoid contamination by drift. Another requirement sought was the presence of a creek in the plot area where fish could be caged. Young hemlock stands of the required height and accessibility were rare. Two plots were laid out close to one another on the south shore of Skidegate Lake on Moresby Island. The other was placed on the north side of the lake. Small creeks crossed Plot 1 on the south shore and Plot 3 on the north shore. The plots were designed to conform with a single swath release by a Grumman Avenger aircraft which is capable of covering a swath 400 feet wide. Because the brush was so dense, no attempt was made to mark the outer boundaries of the plots. Instead, a single base line 30 chains long was run through the center of each plot. Five sample lines were cut at right angles to the base lines at stations 0, 7.5, 15, 23.5, and 30 chains. The sample lines were extended five chains on either side of the base lines and sample stations were marked at one-chain intervals. Each plot then consisted of five sample lines, each with eleven sampling stations. One sample tree was selected at each station. Spray assessment units were placed on shingles nailed to 4 foot stakes driven into the ground as near as possible to the station markers. Small trees and brush near the stations were felled to ensure unobstructed fall of spray to the units. Deposit assessment units consisted of an oil sensitive dye card and one 9 cm. petri dish containing nutrient agar.

At the outset it was hoped that the DDT operational

spray would be completed at least two weeks before B.t. was applied. The DDT was applied when the larvae were in about the mid-second instar, while the B.t. was to be applied when the larvae were mostly in the fourth instar. Development of budworm in the mature stands was much slower than in the young stands. Therefore, by the time mature forest spraying was finished it was time to spray the bacillus on the young stands. The last DDT spray was applied July 23rd, and the bacterium was sprayed on July 24th.

Up to that time the weather had been cool and wet. The maximum air temperature at Sandspit Airport had not exceeded 60° F. Natural mortality of the budworm was, consequently, high. When the plots were established only a light budworm infestation was present; by the time the pre-spray samples were taken on July 22nd and 23rd, the infestation had declined to a very low level. Over three-quarters of the samples were without living larvae, and the average was only 3.3 living insects per 10 square feet of foliage.

Faced with these data, a decision had to be made to cancel or proceed with the experiment. It was obvious that a population reduction assessment could not be made without increasing the sampling at least tenfold. The crew available could not possibly cope with a much increased sampling programme. Nor was time available to try to select plots in other areas where the population might be higher. If the experiment were cancelled the Thuricide donated by Bioferm Corporation and Stauffer Chemical Company would have been wasted, and the time and effort already expended on the plots would have been lost. With materials, aircraft, crew, and observers all on hand, a decision was made to proceed, with the hope that valuable information would be gained with respect to formulation, deposit, and viability of the material. In addition, it might be learned if the Thuricide applied from the air could kill the few budworm present.

Information received from the New Brunswick trial showed that oil suspension was superior to water suspensions of the Thuricide, but that both formulations produced deposits displaying clumping of spores that were large enough to be visible to the unaided eye. To improve the chances of success in the B.C. experiment, only oil suspension was used, and Dr. R.A. Fisher, Vice President of Bioferm Corporation, designed a formulation incorporating additives that would reduce the clumping and settling tendencies of the suspension. The formulation per 100 U.S. gallons was;

Thuricide SO-75.....	150 lb.
Wetting Agent No. 3 .....	4.5 U.S. gal.
Microcel A .....	35 lb.
Sodium nitrate .....	8 lb.
Diesel fuel oil .....	73 gal.
Water .....	8.5 gal.



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Wetting Agent No. 3 .....	4.5 U.S. gal.
Microcel A .....	35 lb.
Sodium nitrate .....	8 lb.
Diesel fuel oil .....	73 gal.
Water .....	8.5 gal.

One hundred fifty pounds of the Thuricide SO-75 was a special concentrate prepared for the experiment by Bioferm Corporation. It contains 60 billion viable spores of B.t. per gram and 3.6 per cent by weight of Petro A.G., a wetting agent. Wetting agent No. 3 was a 1:1 blend of Atlas' emulsifiers Span 80 and Tween 80. Microcel A is a product of Johns Mansfield Company.

Plot 2, maintained as a check, was sprayed with three passes over its center line with fuel oil and additives other than Thuricide. Two and three passes were sprayed over Plots 1 and 3, respectively, with the full formulation. The speed of the aircraft was 160 m.p.h. and its emission rate was 112 U.S. gallons per minute. This meant that approximately 32 gallons containing 48 lbs. of Thuricide were applied to Plot 1, and 48 gallons containing 72 lbs. of Thuricide were sprayed on Plot 3.

Generally for DDT spraying, it is considered that the effective swath of the Avenger is about 400 feet. The plots were 660 feet wide to allow for lateral drift. To calculate the per acre dosage on the full plot size of 30 acres is, therefore, not realistic. If the 400 foot swath width is arbitrarily chosen as the basis, the nominal rates were about 2.67 lb. of Thuricide in 1.78 gallons per acre on Plot 1, and 4 lb. Thuricide in 2.67 gallons per acre on Plot 3.

The aircraft was not fitted with a mechanical or hydraulic tank agitator for DDT spraying, so that it was necessary to improvise equipment for the job. Mr. R. Houghton and Mr. M. Taylor of Skyway Air Services fitted a hand-operated paddle agitator to a 55 U.S. gallon barrel which was secured in the gunner's cockpit of the aircraft. An instantaneous shut-off valve was fitted between the outlet of the barrel and a gasoline motor driven pump. The pump fed liquid from the barrel to the spray boom which was equipped with 20 downward facing,  $\frac{1}{4}$  inch pipe nozzles. All screens and shut-off diaphragms were removed from the nozzles. Mr. Houghton flew in the aircraft and by means of an improvised intercommunication system, operated the spray shut-off valve upon signal from the pilot. Without the nozzle diaphragms installed, spray release was not instantaneous after the valve was opened because the pump had to fill the distribution hoses and spray booms with liquid. By operating the hand-cranked agitator from loading time until spray release, Houghton was able to prevent any possible sedimentation of the Thuricide.

The spray was mixed by Dr. Fisher assisted by Mr. Jackson and Mr. Randall. The first batch of 40 gallons for Plot 1 was mixed without mechanical agitation. Some sedimentation occurred; after the mix was pumped into the aircraft, about 2 pounds of Thuricide remained in the mixing barrel. The second batch of 55 gallons for Plot 3 was mixed with the aid of a mechanical agitator improvised by fitting a paddle to an auger attachment on a power saw - an apparatus not unlike the "Lightning"



mixer used in New Brunswick. This mixer proved very satisfactory and no Thuricide settled out of the second batch.

With the equipment available, radio communication between the plots and the airport was not adequate. A pre-arranged schedule called for Plot 2 to be sprayed at 6:00 a.m., Plot 1 at 6:30, and Plot 3 at 7:00 a.m. Ten men set out and gathered the spray cards and agar plates. The plates were uncovered as soon as they were placed out on the shingles. Five minutes after the last pass had been released over each plot the cards and plates were gathered.

Weather during the preceding week had been unsettled with local rain squalls being common. July 24th was no exception. Low cloud clung to the surrounding hills. Balloon and yellow cloth markers were used to guide the pilot over the center lines of the plots. Plots 1 and 2 were well defined because both base lines started in line with one end of a bridge crossing the lake. Smoke bombs were on hand, but were not used lest the smoke add to the already deteriorating visibility.

Plot 2 was sprayed with oil by 6:30 a.m. Spray drift was more or less parallel to the flight line and to rearward, thus compensating for late opening of the spray valve on one of the three passes.

While the aircraft was reloading with the first mix of Thuricide, a very light rain began to fall on Plot 1. It stopped before spraying was finished, but it was sufficient to dampen the foliage and the spray deposit cards. On the first pass there was a slight delay in releasing and stopping the spray with the result that the first one-quarter of the plot received spray from only one pass. The second pass was perfect in every respect. There was no doubt that the aircraft would be on line over this plot because a swath of scattered mature trees had been felled to allow the aircraft to fly closer to the ground. Near the center of the plot the aircraft had to be flown beneath the level of these old trees standing on a small ridge that transected the plot. A slight southerly breeze drifted the spray to the northerly half of the plot.

Visibility deteriorated after Plot 1 was sprayed. Plot 3 was in such a location that a ridge lay across the flight line about one-half mile to the west of the plot. The pilot stayed at the airport until visibility improved. Without good radio contact, it was necessary to use a charter aircraft supplied by B.C. Loggers' Association to report flying conditions. The charter aircraft was flown to the lake where the pilot remained until he could report adequate visibility. Spray was not applied until 9:30 a.m. All three passes were about 50 feet south of the center line, but a compensating northerly spray drift resulted in a relatively uniform deposit over the plot. Although the agar plates had

been exposed for over an hour before spraying was begun, contaminants did not detract from the B.t. colony counts obtained.

Deposit on both plots was plainly visible. Clumps of solids could be seen on leaves and rocks in many places.

The weather cleared on the afternoon of the day the plots were sprayed and remained warm and dry for two weeks. Light overnight dews were characteristic of the week following spraying.

As time permitted before the spraying was begun, branch tips of trees in Plot 1 were colonized with 15 to 30 budworm larvae. These implanted larvae were sampled on July 26th, 29th and 31st, and August 3rd.

With much work still to be done on the DDT spray assessment during the week following the Thuricide trial, only a limited number of samples from the B.t. plots could be examined. On July 27th the first and only post-spray sampling of the B.t. plots was done. With the very low population present it was decided to concentrate sampling on trees that had yielded larvae on the pre-spray samples. Ten 18 inch branch tips were taken from trees that had had larvae, and two were cut from the other sample trees. A total of 548 samples yielded only 82 living and 101 dead larvae.

On July 25th, Dr. Angus and Dr. Heimpel set up individual rearings of healthy larvae, collected from unsprayed areas, on foliage collected at Plot 1 near station b-4 and at Plot 3 near station c-3. These were shipped immediately to the Insect Pathology Research Institute at Sault Ste. Marie where they were reared until pupation or death. Diagnosis of dead larvae showed that over 80 per cent were infected with the bacillus.

Foliage samples for residual spore counts were cut during the evenings of July 24th and 27th at the two stations cited in the preceding paragraph. The counts were made by Bioferm Corporation under the supervision of Dr. Fisher at Wasco, California. Spore counts on the foliage collected 12 hours after application were high enough to expect budworm mortality. By July 27th about 80 hours after application, the deposit dropped to a level that was at or below the expected lethal level. The decline in deposit was surprisingly rapid in view of the favourable weather following spraying.

Coho salmon fry were caged in screen boxes in the small creeks running through the two plots sprayed with Thuricide by Fisheries officers, Todd and McLean. Their verbal report indicated that none of the fish succumbed in either location and that no mortality was noted of the natural fish populations present.



Since this is intended to be only an informal account of events surrounding the experiment, it is not the place for further discussion or conclusions. It is sufficient to note that the Thuricide reached the foliage in viable and toxic condition, that some but not all of the budworm succumbed, and that deterioration of the deposit was rapid.

By

J.M.Kinghorn  
Research Officer  
Forest Biology Division.

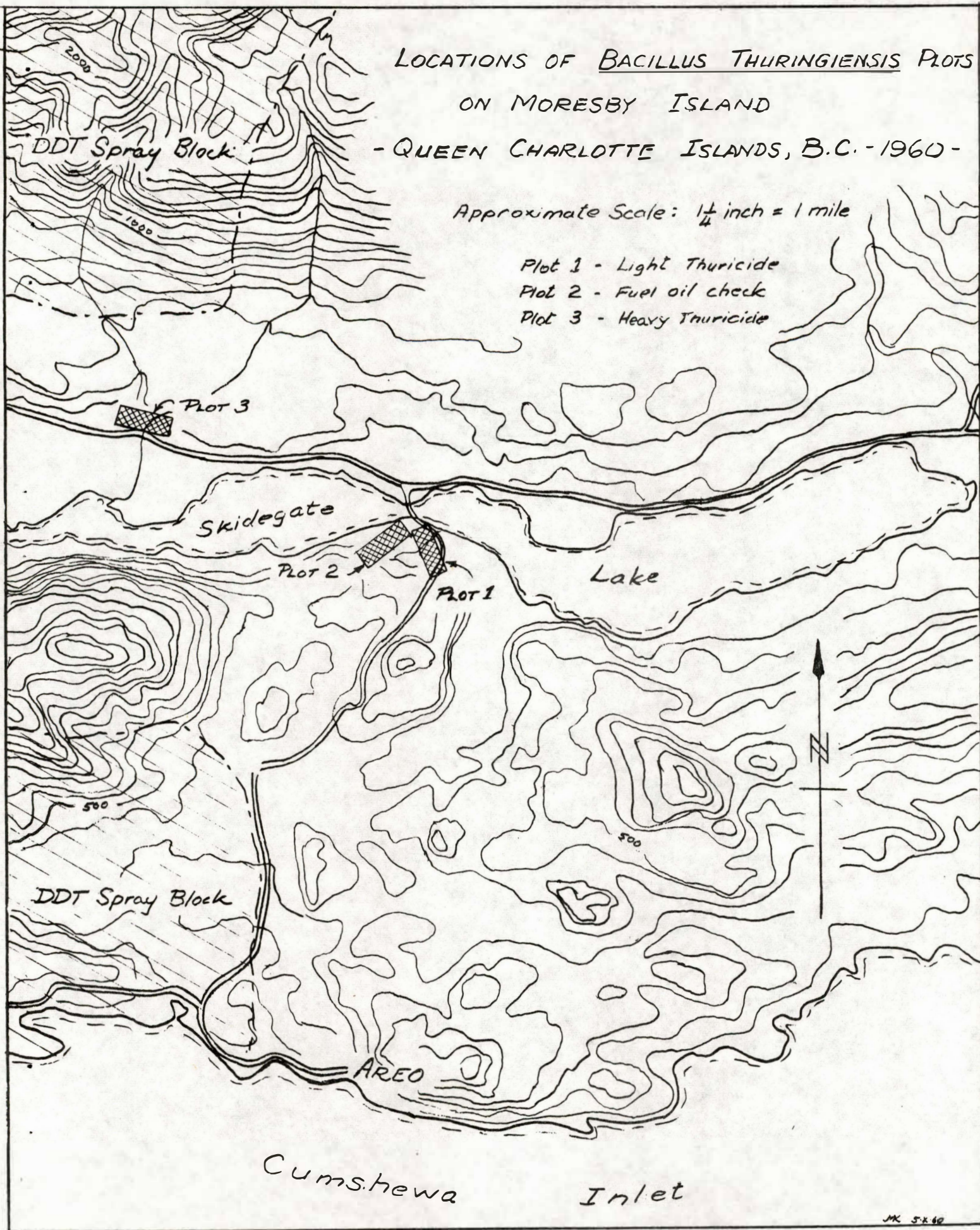
LOCATIONS OF BACILLUS THURINGIENSIS PLOTS  
ON MORESBY ISLAND  
- QUEEN CHARLOTTE ISLANDS, B.C. - 1960 -

Approximate Scale:  $1\frac{1}{4}$  inch = 1 mile

Plot 1 - Light Thuricide

Plot 2 - Fuel oil check

Plot 3 - Heavy Thuricide





Appendix No. 5

INDENTURE OF AGREEMENT made this 16th day of May  
in the year of our Lord one thousand nine hundred and sixty.

BETWEEN:

B.C. LOGGERS ASSOCIATION, having offices at 550  
Burrard Street, in the city of Vancouver, Province  
of British Columbia,

(hereinafter called "the Association")

OF THE ONE PART;

AND:

SKYWAY AIR SERVICES LTD., a company incorporated  
under the laws of the Province of British Columbia,  
and having its Head Office at Langley, in the said  
Province,

(hereinafter called "the Operator")

OF THE OTHER PART:

W H E R E A S:

A. The Association intends to carry out during 1960 an aerial spraying project directed against the Blackheaded Budworm infestation of timber lands on the Queen Charlotte Islands in the Province of British Columbia, over an area of 31,160 acres more or less as marked and outlined in Sketch marked "A" hereto (hereinafter referred to as "the project");

B. The project will be under the direct supervision and control of a Project Director appointed by the Association;

C. The Operator is licensed to engage in such an operation and has enjoyed wide experience in similar operations in the Province of British Columbia and elsewhere in Canada;

D. The parties hereto are desirous of entering into an Agreement under the terms of which the Operator will furnish the Company with all aircraft, personnel, material and equipment not otherwise herein provided for required to perform the aerial spraying to be carried out in the course of the project.

NOW THEREFORE THIS AGREEMENT WITNESSETH that the parties hereto have agreed one with the other as follows;

1. The Operator will furnish one (1) Grumman TBM single-engined aircraft (hereinafter called "aircraft") at Sandspit, Q.C.I., with 1900 h.p. Wright 2600-20 engine equipped with boom-type spray equipment in accordance with the specifications set out in Paragraph 3 hereof, and provide for one stand-by aircraft of the same specifications aircraft maintenance crews and ground and air supervisors for the flying operations to be carried out in the course of the project, also all spray material and equipment required for preparation of spray material and the maintenance of spray material and all personnel and equipment (save as herein otherwise provided).

2. The Operator shall be responsible for carrying out of aerial spraying operations including experimental spraying over the prescribed area during the time appointed as directed by the Project Director who, it is understood and agreed, will be responsible for the overall planning and conduct of the spraying project and whose decision on all matters pertaining to the conduct of the project shall be final.

3. The general spraying equipment specifications referred to shall be as follows:

Aircraft will be equipped with leakproof spray distribution systems of the boom type, capable of applying the insecticide as a mist with an average spray droplet size of 150 to 300 microns. Spraying apparatus will include the following specific parts and features:

- (a) Leakproof metal insecticide tanks with exterior inlets and easily discernible green inlet and cap markings. The filler necks and vents will be of such design and size as to permit rapid filling or dumping of tanks and to prevent spillage from surging. The minimum opening of the filler neck will be two (2) inches.
- (b) Pumping systems capable of maintaining a constant set pressure of at least twenty-five (25) pounds per square inch at varying flying speeds.
- (c) An emergency dump valve with at least a five inch outlet for each insecticide tank of the aircraft tank(s) properly vented. The control lever will be substantially mounted in the cockpit within easy reach of the pilot when he is wearing tight shoulder harness. The dump valve will be of a type which can be closed only when the aircraft is on the ground.
- (d) Positive action leakproof shut-off valve capable of eliminating all dribble.



4. Aircraft engines in aircraft will be in first class operating condition and will not have been operated more than 550 hours since last major overhaul.

5. Aircraft will be equipped with the following instruments:

- (I)       Airspeed indicator;
- (II)       Magnetic Compass;
- (III)      Sensitive Altimeter;
- (IV)      Turn and Bank Indicator;
- (V)       Timepiece (may be carried by pilot);
- (VI)      Tachometer;
- (VII)     Fire extinguisher;
- (VIII)     2 way radio.

- 6.
- (a) Pilots and aircraft will be equipped with adequate shoulder harness, attached to aircraft structure if adequate stability cannot otherwise be obtained, and will have quick detachable fittings.
  - (b) Aircraft will have red inlet and cap markings on all gasoline tanks.
  - (c) Crash helmets of a hard material at least equal to the type used by dirt track race drivers and shoulder harness will be worn by all pilots during flying operations.
  - (d) For reasons of search and safety smoke generators will be carried by all pilots engaged in the performance of this Agreement.

7. In addition to or notwithstanding any specific provisions relative thereto, herein contained, the Operator covenants that all pilots and aircraft will at all times material to this Agreement comply with the Air Regulations of Canada and any other requirements of the Department of Transport or other governing body in all respects and particularly with respect to the condition, equipment and operation of the aircraft and the qualifications and equipment of the pilots.

8. The general aircraft operational requirements or limitations are as follows;

- (a) A forty-five (45) minutes' reserve supply of fuel over the amount needed for the round trip will be required for each flight.
- (b) The gross weight of the aircraft as approved by the Department of Transport will not be exceeded.

- (c) A line inspection will be performed by a properly certificated and rated mechanic each day on each aircraft flown and these inspections will be certified in the aircraft log book.

9. The Association will provide for use by the Operator hereunder lodging and subsistence at Sandspit, British Columbia, or in the vicinity thereof for all personnel employed by the Operator and engaged in the project for its duration as specified herein.

10. The Operator shall provide for use in the project the following:

- (a) A chief Ground Supervisor who will remain on the project for its duration and shall directly supervise the Operator's ground operations.
- (b) Adequate qualified personnel for the operation of all aircraft, and to qualify for the operation of the aircraft to be used for spraying each pilot thereof must have a valid commercial pilot's license with current medical certificate. Pilots who have not had at least one season of experience before the spraying will be trained over forest areas with no less than five hours training with an experienced forest spray pilot and a minimum of one hour of familiarization flight in aircraft to be flown. The Operator will certify in writing, if so requested by the Association, as to the qualifications of each pilot and the training he has received.
- (c) The Operator shall maintain a pilot pool from which additional pilots may be obtained on short notice.
- (d) In the event that a pilot is reported unsatisfactory by the Chief Pilot, he shall be removed from the project by the Operator and replaced from reserve without delay.
- (e) Adequate ground personnel for the servicing and repair of aircraft at the rate of at least one mechanic for each two aircraft operated, and such mechanic or mechanics will be properly licensed to meet Department of Transport requirements regarding certification of aircraft and engines as to airworthiness.



- (f) The Operator shall be responsible for and supply extra parts, materials, supplies, facilities, equipment and tools for servicing and maintaining aircraft engines and accessories, propellers and spraying equipment in continuous operations. In addition the Operator will furnish all gas and oil required for use in all the said aircraft.
- 11.
- (a) The Operator will furnish 4,000 gallons, U.S. measure of insecticide containing 2 lbs. technical grade D.D.T. per U.S.gallon. This will be formulated as a concentrate of D.D.T. in W.T.Base Oil having characteristics as approved by the Chemical Control Section, Forest Biology Division, Federal Department of Agriculture. This concentrate will be further diluted at the Queen Charlotte Islands with fuel oil also supplied by the Operator to give a final material containing  $\frac{1}{4}$  lb. technical grade D.D.T. per U.S. gallon of solution.
  - (b) The completed concentrate will be available for testing and samples will be supplied from the storage drums in adequate time for analysis in Ottawa prior to shipping the material to the Queen Charlotte Islands.
  - (c) The formulation tanks, shipping drums and storage tanks shall be thoroughly cleaned and available for inspection by the Association before being filled with spray.
  - (d) All material shall be pumped through strains before loading into aircraft.

12. The Operator will provide adequate facilities for the storage of supplies and equipment.

13. It is understood and agreed that the exact time for the commencement of spraying operations and the sequence of treatment of individual blocks will be determined to a large extent by insect development. Entomological observations will be made by the Association and Government Authorities prior to and during spraying operations and all decisions relative to the time of commencement of the project, timing and sequence of applications will be made by the Project Director.

Aircraft will be assembled at Sandspit Airfield together with all spray equipment and material, maintenance supplies and personnel and equipment ready for the operation on a date during the month of June to be announced by him on at least ten (10) days notice to the Operator, and then will remain on the project until

completion thereof. The project shall be considered to have been completed upon the happening of any one of the following events:

- (i) When the project has been completed to the satisfaction of the Project Director.
- (ii) When insecticide furnished by the Operator has been exhausted.
- (iii) When the Project Director is advised by his entomologist that the state of the insects has become such that the spraying project is no longer effective and the Project Director declares the project closed down.

14.

- (a) Calibration of all spray aircraft will be carried out prior to the beginning of spraying by the Chemical Control Section of the Division of Forest Biology, Department of Agriculture to the specification as set forth in Schedule "B" hereto.
- (b) Calibration may be checked by authorized personnel of the Association.
- (c) All required changes or adjustments will be made by the Operator to the satisfaction of the Association and thereafter no further adjustment shall be made to the spray equipment of any aircraft other than by way of agreement between the Project Director and the Chief Ground Supervisor.

15.

- (a) When and where possible spray applications will be made at the height of from 75 to 150 feet above the tree-top level and in all other instances at minimum heights conducive to effective application and safe flying as agreed between the Project Director and Chief Ground Supervisor after conference. The Chief Pilot of the Operator will make weather observations on the project area while applications are being made and it is understood and agreed that if in the judgment of the Project Director and the said Chief Pilot, wind velocity, excessive turbulence, rain or other atmospheric conditions will diminish the effectiveness of the spray, spraying operations will be discontinued by the order of the Project Director.
- (b) Checking stations may be maintained by the Association in any areas where spray is applied, and any



inadequacies in spray distribution determined thereby by the Project Director or determined by the Operator's Chief Pilot or Chief Ground Supervisor will be corrected by the Operator without cost to the Association other than the actual cost of gas, oil and insecticide used in the respraying.

16. In the event of the failure of the Operator to complete the operation, otherwise than as a result of weather conditions, insect developments or other unusual and unforeseeable circumstances beyond its control at the project, the Association reserves the right to procure and place in use aircraft and pilots from other sources and the Operator shall be and become responsible and liable for any excess cost occasioned to the Association thereby.

17. The Operator shall provide and maintain at its own cost and expense insurance against public liability and property damage in the minimum amount of five hundred thousand dollars (\$500,000.00) and against damage or injury by chemicals to a minimum of one hundred thousand dollars (\$100,000.00) and will require that any flying subcontractor or subcontractors from it carry additional public liability and property damage insurance to the minimum amount required by the Air Transport Board in such a case, and the Operator agrees to indemnify the Association from and against all claims or demands for any injury or damage caused, arising from the operation of any of the aircraft supplied by the Operator hereunder in the carrying out of the above operation to the amount of the said insurance only.

18. Aircraft shall be and remain in possession of a valid certificate of airworthiness during the term of the project.

19. The Project Director and the Chief Pilot will settle on a spray plan dividing the areas to be sprayed into blocks ranging in size from 2,000 to 8,000 acres, and averaging about 5,000 acres. Topographical features other than rivers will determine the boundaries between the spray blocks. The Operator will accept same as the blocks to be sprayed in the project.

20. (a) In consideration of the services to be performed and the equipment, materials and personnel to be supplied by the Operator hereunder, the Association will pay to the Operator a sum equal to One dollar and Seventy-nine cents (\$1.79) Canadian Funds for each gallon United States measure of insecticide sprayed in Accordance with the provisions of this Agreement except where used in respraying when cost of insecticide will be paid as provided in Clause 15(b) hereof. The Operator will submit invoices weekly and the Association

will pay same within fifteen (15) days of receipt and invoices finally submitted shall be paid by the Association within thirty (30) days of termination of the project.

- (b) The Association shall be under no obligation to pay for gallons sprayed without authorization of the Project Director.

21. In the event that the Operator being ready and willing to carry out its duties and obligations on the project as herein provided shall be prevented from performing any spraying operations hereunder by weather conditions, status of insect development or other extraordinary or unforeseeable conditions and such have been agreed upon by the Project Director on behalf of the Association and the Chief Ground Supervisor on behalf of the Operator, then the Association will pay to the Operator the sum of \$49,544.40 less the laid-down cost of unmixed diesel oil and gas and oil for aircraft as would be required for the project if it were to have been completed, together with the estimated amount of landing fees for same.

22. In the further event that the Operator being ready and willing to carry out its duties and obligations hereunder shall be prevented from completing spraying operations hereunder by any of the reasons stated in Clause 21 hereof, then the Operator shall be entitled to be paid and the Association will pay to the Operator notwithstanding that the project has not been completed the amount which the Operator shall at such times have earned pursuant to Clause 20(a) hereof and, in addition thereto, a sum calculated at \$1.59 per acre for the remaining unsprayed acreage less the laid-down cost of unmixed diesel oil and gas and oil for aircraft which would have been required if the project had been completed, together with estimated amount of landing fees for same.

23. In the event that a federal tax is charged to and payable by the Operator in respect to insecticide to be used by it on the project, the Association shall pay the amount of the tax to the Operator upon being satisfied that the Operator has paid same.

24. In case of any dispute arising between the parties hereto or as a result of any of their dealings under this Agreement the same shall be submitted to arbitration under the provisions of the Arbitration Act of the Province of British Columbia.

25. This Agreement shall be governed by the laws of the Province of British Columbia.

26. This Agreement is subject to the approval of the Air Transport Board and the Department of Transport if such approval is required.



27. The Operator shall not carry passengers at any time while on spraying operations other than employees of the Company.

IN WITNESS WHEREOF the respective corporate seals of the parties hereto to be affixed by the hands of their proper officers thereunto duly authorized this 16th day of May A.D., 1960.

The CORPORATE SEAL of B.C.LOGGERS  
ASSOCIATION was hereunto affixed  
in the presence of:

The CORPORATE SEAL of SKYWAY AIR  
SERVICES LTD., was hereunto affixed  
in the presence of:

A. SPECIFICATIONS GOVERNING SPRAY EMISSION PERFORMANCE OF TBM AIRCRAFT IN THE BLACK-HEADED BUDWORM SPRAY PROGRAM, VANCOUVER ISLAND, B.C. 1957.

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Spray to be emitted from aircraft according to the following specifications. The aircraft are required to:-

- (a) Emit insecticide at a minimum rate of 1 gallon per acre.
- (b) Deposit a spray which has a droplet Mass Median Diameter of 200 to 275 microns.
- (c) Deposit a minimum of 0.2 gallons per acre at ground level.
- (d) Deposit a minimum of 15 droplets per square centimeter at ground level.
- (e) (c) or (d) must obtain or re-spraying is recommended.

B. CHARACTERISTICS OF AIRCRAFT OPERATION THAT HAVE A BEARING ON THE ABOVE SPECIFICATIONS

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In order to meet these principal specifications, it will be necessary to exert control of swath width (flight interval) and insecticide delivery rate in relation to speed and altitude of flight. Therefore, tests to be conducted on each aircraft by the Chemical Control Section, Forest Biology Division, Canada Department of Agriculture, to determine (i) allowable swath width in relation to altitude and speed of flight and insecticide delivery capacity; (ii) suitable nozzle aperture sizes and nozzle arrangement to provide acceptable spray break-up as recovered on the ground.

Spray Material

The fluid to be used in calibration tests is to be the same as that used in the spray program. Dye is to be added to facilitate assessment. Flying speed should be relatively constant and indicated in the contract.

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SCHEDULE "B"



May, 1960, THIS AGREEMENT is made this twenty-fourth day of

BETWEEN:

B.C. LOGGERS' ASSOCIATION  
of 550 Burrard Street, Vancouver,  
British Columbia,

as "the Association"

OF THE FIRST PART;

AND:

CROWN ZELLERBACH CANADA LIMITED,  
MacMILLAN, BLOEDEL AND POWELL RIVER LIMITED,  
RAYONIER CANADA LIMITED,  
all of Vancouver, British Columbia,

as "the Companies"

OF THE SECOND PART;

WHEREAS:

(A) The Association intends to carry out during 1960 an aerial spraying project directed against the Black Headed Budworm infestation of timber lands on Queen Charlotte Islands, British Columbia, comprising an area of approximately 31,160 acres, as shown on the sketch hereto annexed and marked "A", hereinafter referred to as "the Project":

(B) The Association has entered into an agreement under date of 16th May, 1960, with Skyway Air Services Ltd., for carrying out the said Project, hereinafter referred to as "the Project Agreement", a copy of which is hereto annexed marked "B";

(C) Unalienated title to approximately 4,374 acres of the said project area and the timber thereon, lies with the Government of British Columbia; the timber or the right to cut the timber on approximately 4,722 acres is held by Rayonier Canada Limited, under Tree Farm Licence No. 24; and the timber or the right to cut the timber on approximately 22,064 acres of the said area is held by the Companies shown below in the following amounts -

Crown Zellerbach Canada Limited	14,774 acres	66.96%
MacMillan, Bloedel and Powell	7,290 "	33.04%
River Limited	<u>22,064 acres</u>	<u>100.00%</u>

(D) The Project is being entered into primarily for the benefit of the Companies and the Association is entering into the Project Agreement as a matter of convenience and solely on behalf of the Companies;

(E) The Government of British Columbia has agreed to bear one-third of the cost of spraying the lands and timber thereon held by MacMillan, Bloedel and Powell River Limited, Crown Zellerbach Canada Limited, and the lands to which unalienated title lies with the said Government of British Columbia, totalling approximately 26,438 acres.

(F) Crown Zellerbach Canada Limited, and MacMillan, Bloedel and Powell River Limited have agreed to bear the remaining two-thirds of the cost of spraying the lands referred to in Paragraph (E) above, on the basis of the percentages shown in Paragraph (G).

(G) Rayonier Canada Limited have agreed to bear all of the cost of spraying approximately 4,722 acres held by their company under Tree Farm Licence No.24.

WITNESSETH that in consideration of the premises and of the mutual covenants, provisos and conditions hereinafter contained the parties agree as follows:

1. The Association will, to the best of its ability carry out its covenants contained in the Project Agreement and procure the full and complete performance of the obligations of Skyway Air Services Ltd., thereunder.

2. The Companies will from time to time pay to the Association monies as required to carry out the Project and to comply with the terms of the Project Agreement, such monies to be kept by the Association in a separate trust account and an accounting thereof to be rendered to the Companies at such reasonable times as they may request.

3. All payments made by the Province of British Columbia will be paid into the said trust account and used for purposes of carrying out the Project.

4. The Companies agree to indemnify and do hereby indemnify the Association against any costs, expenses and claims of any kind whatsoever which may be incurred by the Association in entering into the Project Agreement and in carrying out the Project.

5. The parties agree to execute such further assurances as may be reasonably necessary to more fully carry out the intent of this agreement.

6. This agreement shall ensure to the benefit of and be



binding upon the parties hereto, their successors and assigns.

IN WITNESS WHEREOF the parties hereto have hereunto caused their corporate seals to be affixed, attested by the hands of their proper officers in that behalf, the day and year first above written.

THE CORPORATE SEAL OF B.C. )  
LOGGERS' ASSOCIATION was )  
hereunto affixed in the )  
presence of: )

THE CORPORATE SEAL OF CROWN )  
ZELLERBACH CANADA LIMITED )  
was hereunto affixed in the )  
presence of: )

THE CORPORATE SEAL OF )  
MacMILLAN, BLOEDEL AND )  
POWELL RIVER LIMITED was )  
hereunto affixed in the )  
presence of: )

THE CORPORATE SEAL OF RAYONIER )  
CANADA LIMITED, was hereunto )  
affixed in the presence of: )

THIS AGREEMENT made the 3rd day of June A.D.1960

BETWEEN

THE MINISTER OF LANDS AND FORESTS  
of the Province of British  
Columbia who, with his successors  
in office, (hereinafter referred  
to as "the Minister")

AND

OF THE FIRST PART

BRITISH COLUMBIA LOGGERS' ASSOCIA-  
TION incorporated under the  
Societies Act of the Province of  
British Columbia and having an  
office at 550 Burrard Street, in  
the City of Vancouver, in the said  
Province, (hereinafter referred to  
as "the Association")

OF THE SECOND PART:

WHEREAS the Association pursuant to agreements more specifically hereinafter mentioned has undertaken an aerial spraying project (hereinafter referred to as "the project") for the control of an infestation of black-headed budworm Acleris variana on the lands hereinafter mentioned and more particularly shown as marked "A" on the plan attached hereto and outlined in red thereon;

AND WHEREAS the Association has entered into an agreement dated the 16th day of May 1960, with Skyways Air Service Limited (hereinafter referred to as "the Skyways Agreement") for the execution and carrying out of the said project;

AND WHEREAS the Association has entered into an agreement dated the 16th day of May 1960 (herein referred to as "the Companies Agreement") wherein Crown Zellerbach Canada Limited, Powell River Company Limited, being the owners or having control of part of the lands located within the area of the project, agree with the Association to contribute to the cost of the said project as set out in the said Companies Agreement;

AND WHEREAS the Minister has agreed with the Association to contribute to the cost of the said project on the terms and conditions hereinafter set forth;

NOW THEREFORE THIS AGREEMENT WITNESSETH THAT in consideration of the premises and the payments hereinafter mentioned the parties hereto agree as follows:

- (1) The Association agrees with the Minister to carry out,



superintend, and execute the project of spraying the said infestation of black-headed budworm on the lands hereinbefore referred to in accordance with the provisions of the said Skyways Agreement.

(2) The Association further agrees to comply with all terms and conditions set forth in the said Skyways Agreement and to insist and to compel the said Skyways Air Service Limited to comply with all the terms and conditions of the said Skyways Agreement.

(3) The Association agrees with the Minister to carry out all terms and conditions of the said Companies Agreement above-mentioned and to insist and compel the said Companies to comply with all the terms and conditions therein set forth. The Association further agrees that all monies contributed by the said Companies shall be held by the Association in trust subject as hereinafter provided.

(4) The Association agrees with the Minister to do all things, supply all information, and afford and make available all facilities for the inspections, examination of books, papers and records, and to furnish all plans, programs, and other information as may be requested by the Minister.

(5) The Minister agrees with the Association to pay the Association an amount being one third of the total cost of treating those areas outlined in red on the plan attached hereto.

(6) The Association agrees with the Minister to hold in trust all monies received by it for the purposes of the project and to disburse the same only for the purposes of the project subject as hereinafter provided. The Association agrees to keep correct and accurate books and accounts of all the receipts and disbursements made of such monies. Such monies shall at no time form part of the funds of the Association, but shall be dealt with and be trust monies designated as such in a separate account thereof for the purposes of the project.

(7) The Association agrees to keep proper accounts of all monies received for the project and make all disbursements and payments due and owing as the same become payable. The Association, in carrying out the said accounting, from time to time shall bill the said Corporations mentioned in the Companies Agreement and the Government of the Province of British Columbia, on account of their respective share of the costs according to the provisions of the said Companies Agreement and this agreement, and shall, where necessary, adjust the billings to ensure that each of the parties mentioned herein shall be charged its/his proper share and if necessary, where overpayment occurs, to reimburse the parties so making the overpayment. Provided always, all receipts and accounts paid from the monies held in trust as above-mentioned shall be subject to the approval of the Minister and subject to be audited by the auditors of the Government of the Province of British Columbia.

(8) The parties agree to execute such further assurances as may be

reasonably necessary to more fully carry out the intent of this agreement.

(9) The Agreement shall enure to the benefit of and be binding upon the parties hereto, their successors and assigns.

IN WITNESS WHEREOF the Minister has hereunto placed his hand and seal and the Association has caused its corporate seal to be affixed, attested by the hands of its proper officers in that behalf, the day and year first above written.

SIGNED, sealed and delivered in )  
the presence of )  
)  
)  
)  
)

Minister of Lands and Forests

SIGNED, sealed and delivered in )  
the presence of )  
)  
)  
)

British Columbia Loggers'  
Association.